Emission-reduction catalysts to enable use of highly efficient CIDI engines

OAAT ACCOMPLISHMENTS

Advanced Catalysts for Clean CIDI Engines

Challenge

Because compression-ignition direct-injection (CIDI) engines have the highest thermal efficiencies of any proven automotive power plant, they are seen as being among the most promising candidates to deliver fuel economies of up to 80 miles per gallon in vehicles being developed under the Partnership for a New Generation of Vehicles Program. Before widespread use of CIDI engines can become a reality, however, their nitrogen oxides (NO_x) emissions must be reduced to meet federal Tier 2 standards, which will go into effect in 2004.

Full-development size (110 cubic inch) catalytic converter in take-apart can assembly.

Technology Description

To overcome this emissions barrier, the U.S. Department of Energy (DOE), DaimlerChrysler Corporation, Ford Motor Company, and General Motors Corporation are working together to develop advanced catalytic materials for catalytic converter systems that reduce NOx emissions from CIDI engines. Research has taken two complementary directions. One involves development of new zeolite-based catalysts that promise to be effective in NO_x removal at high temperatures, while the other focuses on development of platinum (Pt)-based hydrous metal oxide (HMO)-supported catalysts that operate at low temperatures.

Accomplishments

Researchers at Los Alamos National Laboratory (LANL) discovered a new family of Ferrierite (FER) zeolite-based catalysts. Zeolite support materials and catalyst pretreatment procedures were optimized to achieve at least 80% NO_x conversion at high temperatures (250-450° C). However, catalyst exposure to water in the exhaust stream was found to degrade NO_x conversion at temperatures below 400° C.

Researchers at Sandia National Laboratories (SNL) achieved 60% NO_x conversion with the Pt-based/HMO catalysts. This conversion efficiency was not sufficient to meet Tier 2 standards. Subsequent SNL research led to an understanding of the limitations of supported Pt catalysts for NO_x removal in CIDI engines.

Benefits

Substantial NO_x conversion efficiencies have been achieved with advanced catalytic materials.

At the same time, the need for a better approach to NO_x control has been highlighted.

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Commercialization

A number of patents resulted from the research. Patents were issued to SNL for NO_x-adsorbing materials and NO_x-reduction catalysts. LANL filed for a patent on the FER-supported metal catalysts.

SNL also developed a process to transfer technology to its industrial research partners and their designated catalyst suppliers.

Awards

1997 Vice President's PNGV Award

1999 National Laboratory CIDI R&D Award (SNL)

2000 National Laboratory CIDI R&D Award (LANL)

Future Activities

To achieve a NO_x conversion efficiency that meets the Tier 2 standard, SNL's NO_x-reduction reactor will be refitted to support a more promising approach, selective catalytic reduction of NO_x by urea and ammonia. Mixed catalyst applications will also be pursued to increase the NO_x conversion efficiency of lean-burn catalysts.

The effect of water on FER-supported metal catalysts will be explored further. The possible effects of particulates on the NO_x-reduction performance of lean-burn NO_x catalysts will also be investigated.

Partners in Success

- DaimlerChrysler Corporation
- Ford Motor Company
- General Motors Corporation
- Los Alamos National Laboratory
- Oak Ridge National Laboratory
- Sandia National Laboratories